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Three-Dimension Numerical Simulation of Scour Temporal Changes due to Flow in the Downstream of Combined Weirs and Gate Model

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Abstract

Most of weirs create a region with relatively static water in upstream, which can be the place of sediments and wastes deposition in water. Sediments accumulation in upstream changes flow conditions. In this case, combined weir and gate can be propounded as a useful solution. In the present paper, Flow3D was used to numerically simulate temporal changes of scour in combined free flow over weirs and below gates. Numerical modeling was run after fully preparing and the obtained data was analyzed under three-dimensional conditions. Comparing experimental and numerical results with data fitness revealed that determination coefficient (R^2) of the numerical model results to the experimental model results is 0.94. Also, it was found that the relative error of the numerical model results relative to the experimental results equals 7.36%. Further, it was found that at the start of computations in the numerical model, compared to the end of running the model, the turbulent energy dissipation was decreased to 38% and decreasing the turbulent energy dissipation led to the creation of scour hole balance in the numerical model.

Keywords: Numerical Model, Combined Model, Gate Weir, Scour, Bed Sediments, Flow3D.

1. Introduction

Scour refers to the erosion of bed and channel edge due to flow pass as well as the erosion of bed in hydraulic structures downstream as a result of highly intense flow or the erosion of bed due to topical turbulent flows. Heavy costs are spent to control and prevent scour in hydraulic structures downstream every year; therefore, it is necessary to predict it before constructing structure. The expansion of such a phenomenon can endanger the stability of the structure. Also, the accumulation of eroded materials influences the performance of the structure as a result of coastal digit change.

Gregory et al. (1963) reported that flow discharge is increased about 8% when 75% of weir height is filled by sediment [1]. Using the combined structure, the defects of using weir and gate separately can be removed. Hassen and Narayanan (1985) studied scour due to a 2D jet passing under the gate with apron and without apron. In their study, they investigated the effect of particles size, gate openness, inlet jet speed, and apron length on scour [2]. Chatterjee and Ghosh (1980) suggested some relations to compute the time necessary to arrive at balance mode, scour volume at time, maximum scour depth, and scour profile [3]. In an experimental study, Kells et al. (2001) investigated aggregation diameter in sour downstream of sluice gates. The obtained results indicated that high depth dependency and scour zone was as much as

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